Ergonomic Swim Fin Apparatus

U.S. Utility Patent Application of

John Melius

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By John Melius

This utility patent application claims priority of provisional patent application filed February 2, 2001, which is incorporated by reference herein.

Technical Field

This disclosure relates to swim fins used for swimming underwater or at the surface, or as swim fins that can be worn with adapted footwear.

Background of the Invention

This invention relates generally to the field of swimming and diving, and more particularly to an ergonomic swim fin apparatus based on the locomotion methods and strategies used by the most efficient fish. This invention can be assembled to various levels of complexity, to be used to swim at varying degrees of effectiveness and purpose. Much work has been done in recent years in biomimetics to study efficient swimming fish to try to effect a man-made free moving aquatic device that approaches their propulsion , efficiency, acceleration and maneuverability. Universities such as MIT, Northeastern University, the University of Tokai, Japan, the Herriot-Watt University , Edinburgh, Scotland, Texas A&M University and Aeroprobe Corp., and the University of New Mexico and Artificial Muscles Research Institute are all researching various aspects of this

propulsion system, as described in US Patent 6,138,604 and other publications. Scientific analyses developed from free swimming fish and robotic models of fish have been directed towards the development of a pelagic free swimming aquatic vehicle. In the instant invention, applicable principles that parallel these biomimetic studies have been adapted to create a swim fin apparatus that is created for ergonomic human swimming, underwater or at the surface, that will imitate fish and their propulsion , efficiency, acceleration and maneuverability . This swim fin apparatus also allows the swimmer to adapt to various swimming conditions and swimming goals by allowing certain elements of the apparatus to be selectively interchanged to meet these goals. This apparatus also provides an elegant solution for non-swimming problems associated with the general use of swim fins, such as: walking with the swim fins, an easy method for manufacture of said swim fins, and solutions for sore tendons produced by swimming with past swim fins.

A few attempts, most notably US Patents 2,423,571; 2,950,487; 4,934,971 and 5,906,525; have attempted to deal with the fish propulsion problem by focusing on moving a portion of a swim fin which has been shaped like a fish or dolphin tail fin or a variation or such. Simply moving a tail fin through the water (without a flow of water over a "lifting" surface at a correct angle of attack) produces a flopping form with little or no propulsion. At best, the tail fin in this

system acts like a webbed foot, with its associated problems.

US Patent 2,099,973 comes close to adapting the propulsion system of efficient fish type propulsion, but has several inherent problems. First, it employs an upper stiff paddle that has no shaped foot pocket and does not let the toes flex. This would be uncomfortable to use when swimming or walking, because the toes would continually be constricted and under substantial pressure. Second, the lack of a formed foot pocket would cause pressure points on of the top of the user's foot. Third, the flat stiff paddle does nothing to enhance or channel the flow of water over the fin to enhance propulsion. Finally, this patent doesn't include a tail fin that gives "lift" to the propulsion system for increased power and efficiency, as is found with fish propulsion systems.

A pending patent filed by this inventor comes the closest to adapting the system used by fish for propulsion. It uses a stiff flat blade for propulsion, a flexible portion, and a "wing shaped" tail to provide lift. It's a very effective form of locomotion that fulfills all of the requirements for effective fish propulsion system, but it is not as ergonomic in its design with regard to the human foot and anatomy, as is the present invention. The patent pending invention uses a stiff blade that extends beyond the toes which creates unnecessary work and undue pressures on the foot of the swimmer, and makes walking in the fins very difficult.

Secondly, pending patent requires more material in the production of the swim fin, than required by a swim fin disclosed in the present invention, because the pending swim fin must be longer and heavier than the present embodiment shown in FIG. 1, 5, 11, 12 and 15, to produce similar propulsion results.

The vast majority of prior art swim fins have functioned as webbed feet or paddles. Webbed feet and paddles work to push water, but not as efficiently as the propulsion system used by fish. Two clear problems with webbed feet and paddles are that water isn't pushed effectively, and a recovery stroke is required to arrive at a position to properly push on each stroke of the swim fins (a substantial waste of energy and a cause of drag.)

The numbers of patents using the "webbed foot" or "paddle" form of propulsion are too numerous to mention. A selected number of them are mentioned because of their historical importance or superficial resemblance to the instant invention. Each of these prior art patents, simply increase the surface area for pushing water, and they include:

US Patent 74,931, issued in 1868, which the earliest known patent in this art, in which the webbed foot concept is extremely clear, with elongated forms of the toes and fingers which are webbed with cloth.

US Patent 169,396, issued in 1875, is a series of hinged flaps and other

forms positioned above the surface of the foot.

US Patent 281,005, issued in 1883, utilizes hinged flaps connected to the bottom of a shoe form.

US Patent 335,015, issued in 1886, is an ingenious system of retractable flaps positioned at the sides and front of the foot.

US Patent 636,364, issued in 1899, is a form of swim fin worn with a shoe that would balloon out in the backward kick to increase the surface area.

US Patent 1,113,820, issued in 1914, disclosed hinged flaps positioned above a shoe.

US Patent 1,187,963, issued in 1916, disclosed hinged flaps above and to the sides of a shoe.

US Patent 1,374,077, issued in 1921, disclosed swim fins having a single flat surface supported above the shoe that did not move.

US Patent 1,571,462, issued in 1926, disclosed swim fins having an increased surface area, with a wire form on the sides and front of the foot that incorporated a cloth spread under the foot to encompass the wire form.

US Patent 1,729,477, issued in 1929, discloses swim fins with wire forms and cloth, to create a larger form above the shoe.

US Patent 1,788,013, issued in 1931, professes to "provide a device similar

in form to the web-foot of a water bird", with a web form attached to the bottom of a bathing shoe.

US Patent1,911,828, issued in 1933, attaches two hinged fin forms horizontal to the floor to a shoe to create moveable swim fin flaps.

US Patent 2,277,538, issued in 1942, employs swim fins having two hinged flaps attached to a shoe that meet at the top of the shoe.

US Patent 2,672,629, issued in 1954, traps water by a system of wire supports and cloth webbing that surrounds the sides and front of the foot. A small amount of flexibility is provided in the toe portion of the wire supports and webbing.

US Patent 5,795,204, issued in 1998, extends the area of swimming shoes by providing a semi-flexible swim fin flap extending from the bottom of the shoe to the outside side of the foot, which does not extend beyond the toes of the shoe.

Other swim fin designs have tackled design problems along with the problem of propulsion. These patents are representative of many others, dealing with common problems in manufacturing or common usage of the swim fins. US Patent 3,315,286 describes a swim fin that has a hinged swimming blade that enables the swimmer to walk easily while wearing the swim fins. Other known swim fin swivel systems have been developed to aid walking. US Patent

5,597,336 describes a swim fin with an open instep instead of a closed foot pocket, which discloses a simple two piece mold, for use in swim fin production. US Patent 5,975,973 employs an asymmetrical swim fin design that promotes a small amount of rotation while swimming to decrease tendon soreness due to swimming with swim fins.

SUMMARY OF THE INVENTON

The channeling scoop of the present swim fin apparatus is the fundamental element that provides initial propulsion and can be used with traditional swim fins, or with other specially adapted footwear such as sandals or shoes. Because the prerequisite stiff element of the swim fin is located on either side of the foot instead of in front of the toes, the pressures produced from swimming are spread over the entire surface of the foot.

Channeling scoops are located between the flexible joints of the foot (the ankle and toes), and allow the swimmer substantially freer movement, and improve the ease of walking while wearing the swim fin apparatus disclosed herein. The channeling scoops can be used with traditional swim fin forms, and are preferably rounded to channel the water displaced by the user's foot. The present invention is easier and more efficient to use without any loss in propulsion even though the overall length of the swim fin can be substantially shortened. The use of the

channeling scoops enable the capturing of energy used to move the foot through the water (which usually slides off the sides of the foot.)

The present invention also utilizes a flexible blade and symmetrical wing fin. The flexible blade and wing fin enhance and channel water flow from the flexible blade, and channel the flow of water further, while creating lift with the wing fin.

This invention results from the realization that a truly effective swim fin apparatus is a highly efficient form of propulsion for a human while swimming underwater or near the surface of the water. This can be achieved with a semi-rigid foot pocket or specially adapted shoe employing channeling scoops that convert the flow of water across the foot into a propulsion stroke, while allowing the foot the freedom to flex naturally at the ankle and toe joints.

The foot pocket is preferably connected to a flexible flat blade, which is configured to shape and channel the water across a symmetrical wing-shaped tail to provide additional propulsion through lift. The channeling scoops impel the foot to an optimum position during swimming and are preferably removable to selectively increase or decrease the speed and work output of the swimmer.

It is therefore an object of this invention to provide an improved swim fin apparatus having a foot pocket.

It is also an object of this invention to provide channeling scoops on each side of a user's foot to increase propulsion.

It is a further object of this invention to provide a swim fin apparatus utilizing a combination foot pocket, channeling scoops, a symmetrical flexible blade and wing fin extending beyond the profile of the flexible blade.

It is yet another object of this invention to channel water flow from the flexible blade to a symmetrical wing fin, to create additional lift.

These and other objects, features and advantages will be better understood from the following description of the preferred embodiments of this invention, when taken in conjunction with the following drawings.

Brief Description of the Drawings

FIG. 1A is a perspective view of one embodiment of this invention, illustrating a swim fin apparatus with stiff channeling scoops, a flexible blade, and a symmetrical tail fin.

FIG. 1B is a diagrammatic side elevational view of a pelagic free swimming aquatic vehicle as disclosed in US Patent 6,138,604, for comparison of the principles of swimming, utilizing the propulsion system of fish.

FIG. 2 is a perspective drawing of a stiff foot plate located between the ankle and the toe of a swimmer's foot.

FIG. 3 is a perspective drawing of a stiff foot plate extending from the toe out away from the foot, as commonly practiced in the prior art.

FIG. 4 is a plan drawing of a typical prior art swim fin utilizing extended stiffening ribs.

FIG. 5 is a perspective drawing of the prior art swim fin shown in FIG. 4, with the swim fin shown in a neutral position.

FIG. 6 is a perspective drawing of the prior art fin shown in FIG. 4, with the swim fin shown in a typical position during swimming with up stroke.

FIG. 7 is a perspective drawing of the prior art swim fin shown in FIG. 4, with the swim fin shown during a down stroke.

FIG. 8 is a perspective view of a prior art swimming shoe.

FIG. 9 is a perspective of an embodiment of this invention, where a sandal type of shoe is equipped with stiff channeling scoops, to aid in swimming.

FIG. 10 is a perspective view of an embodiment of this invention, with a combination foot pocket, channeling scoops, and a flexible flat blade.

FIG. 11 is a perspective view of an embodiment of this invention, with a combination foot pocket, channeling scoops, and a flexible flat blade, and a tail fin.

FIG. 12 is a perspective view of an embodiment of this invention, with a combination foot pocket, channeling scoops, with a selectively removable flexible

flat blade and a tail fin. The tail fin and the flat blade can be selectively removed or reassembled at will, for ease of transport or storage.

FIG. 13 is a perspective view of an embodiment of this invention, shown in an up-stroke motion, demonstrating the flow of water across the swim fin in dashed lines. An enlarged view shows the use of texture on the flat blade.

FIG. 14 is a side view of an embodiment of this invention, shown in an up-stroke motion, with the flow of water across the swim fin shown in dashed lines.

FIG. 15 is a top view of an embodiment of this invention illustrating the flexible and stiff parts of the swim fin, when used in a down-stroke motion while swimming.

FIG. 16 is a top view of an embodiment of this invention, demonstrating the down-stroke motion, with dashed lines showing the flow of water across the swim fin surface.

FIG. 17 is a side view of an embodiment of this invention, demonstrating the down-stroke motion, with the flow of water across the swim fin surfaces shown in dashed lines.

FIG. 18 is a top rear view of an embodiment of this invention, showing a sandal type of shoe with an articulated sole plate, which is used in conjunction with channeling scoops to aid in swimming.

FIG. 19 is a perspective view of an embodiment of this invention, showing a swim fin with a safety strap, channeling scoops, flexible flat blade and tail fin, wherein the foot pocket is completely open.

FIG. 20 is a perspective view of an embodiment of this invention, in which a sandal type of shoe with an articulated sole plate with channeling scoops.

FIG. 21is a perspective view of an embodiment of this invention, showing a swim fin with a foot pocket that can completely open, channeling scoops, a symmetrical, flexible flat blade, and a symmetrical tail fin, without a safety strap.

FIG. 22 is a rear view of an embodiment of this invention, in which a portion of the flexible blade is shown with a connected tail fin, with the flow of water across the symmetrical wing-like tail fin shown in dashed lines.

FIG. 23 is a perspective rear view of an embodiment of this invention, showing a portion of the flexible blade and connected tail fin, showing the laminar flow of water across the wing-like tail fin in dashed lines.

FIG. 24 is a partial rear view of an embodiment of this invention, wherein a portion of the symmetrical flexible blade is shown with a non-connected tail fin, which is selectively connected for use, and disconnected for ease of shipping and storage.

Detailed Description of the Preferred Embodiments of the Invention

FIG 1A shows a top view of the swim fin apparatus 1000 of the present invention. The user's foot 300 is inserted into the foot-pocket 101 and held in place by a securing strap 103 which extends behind the user's heel. The foot-pocket 101 can be made of a waterproof, semi-flexible material such as polyurethane, plastic or rubber. Preferably, the foot-pocket 101 is resilient and flexible, to conform to the user's foot. Channeling scoops 102 are positioned one each side of the foot-pocket 101, and the channeling scoops 102 are preferably more rigid in construction than the foot pocket. The channeling scoops 102 are preferably made of a different material than the foot-pocket 102. However, the channeling scoops 102 may alternately be made of the same material used for the foot-pocket 101.

As shown in FIG. 1B, the channeling scoops 102 preferably constitute the "RIGID FOREBODY" 1001 of the swim fin apparatus 1000. This ergonomic swim fin apparatus 1000 uses the foot-pocket 101 and the channeling scoops 102 to form the main thrust of the propulsion system. This thrust, together with the vortices created by this thrust, are shaped and enhanced by the "FLEXIBLE AFTERBODY" 1101, which is formed by the flexible blade 110. Finally, the tail fin 120, or "TAIL", enhances propulsion by creating "lift" from the channeled and enhanced water flowing over it at a proper angle of attack, as shown in dashed

lines in FIG. 13 and FIG. 14.

In addition to providing an extremely efficient powerful swimming stroke for propulsion during swimming, the channeling scoops 102 also impel the swimmer to position the user's feet in the most advantageous position for each swimming stroke movement. This embodiment 1000 can be manufactured from dissimilar materials and assembled into the embodiment shown in FIG. 1, or manufactured from a single material created as a single unit, to suit manufacturing preference.

This drawing also shows small vortices formed by grooves, 1011, 1101, 1021 and 1201, in the surface of the swim fin apparatus 1000 to enhance the production of vortices during swimming. These small grooves 1011, 1101, 1021, and 1201 imitate the scales and small grooves found on the skin and fins of some fish. It is speculated that these small vortices act as small "ball bearings" which serve to reduce drag. These small grooves 1011, 1101, 1021 and 1201 are not essential to the function of this swim fin apparatus 1000, and the swim fin apparatus 1000 disclosed herein, may alternately be provided with smooth surfaces. The surface of the swim fin apparatus 1000 may also be textured in a manner shown in FIG. 13, to simulate fish scales. These grooves 1011, 1101, 1021 and 1201 enhance performance, but may be eliminated, should they cause

difficulty in manufacturing.

FIG. 1B shows a second diagrammatic side view of a pelagic free swimming aquatic vehicle, disclosed in US Patent 6,138,604, which illustrate some features of the scientific research being done at major Universities such as MIT and others. Although this work is the study of aquatic vehicles, instead of swim fins, much of the information in these studies, parallels the conclusions that are reached in this ergonomic swim fin apparatus 1000. Note the similarity of the "RIGID FOREBODY" 1001, "FLEXIBLE AFTERBODY" 1101, and the symmetrical "TAIL" 120 shown in the preferred embodiment of this invention, and U.S. patent 6,138,604 shown in FIG. 1B. The research in 6,138,604 suggests that the "RIGID FOREBODY' 1001 should constitute 40% to 80% of the proportion of the vehicle (not including the tail.) In research done on prototypes of this swim fin apparatus 1000, these figures seem to hold true.

Although there are many differences between the two areas of research, many parallels may be drawn, since both are based on the biomimetics of the swimming system employed by fish.

FIG. 2 and FIG.3 illustrate the differences in mechanical advantage by moving the stiff foot plate 50, "the Paddle", of the swim fin closer to the heal of the foot. FIG. 2 represents the swim fin apparatus 1000 presented in the present

patent application, and FIG. 3 shows the methods used by the vast majority of swim fins in operation at present.

As shown in FIG. 2, the part of the swim fin that causes the water to move initially in the swimming stroke, the stiff foot plate 50, is placed between the heel and toe of the foot. This represents, in a simplified form, the corresponding foot-pocket and channeling scoops found in FIG. 1.

The swim fin apparatus shown in FIG. 3, positions the one end of the stiff foot plate 50 in proximity to the toes, and the opposite end extends beyond the toes. This represents the prior art swim fins, as shown in FIG. 4, FIG. 5, FIG. 6, and FIG. 7.

As shown in FIG. 2 and FIG. 3, the area enclosed in the stiff foot plate 50 is the same, and the leg and foot 300 are held to the stiff foot plate 50 by a securing strap 103. The forces 45 pushing down on the leg and foot 300 as it is moved through the water, is the same in both cases no matter where the stiff foot plate is located, because the area of the leg and foot 300 is the same. The area occupied by the leg and foot 300 overlaps in the area of the stiff foot plate 50 as shown in FIG. 2, and therefore exposes less area to water pressure 55 than in FIG. 3.

Considering the round form of the top of the leg and foot 300, the force 45 that would be exerted against it would not produce much propulsion because the

water would simply run around the leg and foot 300. But the water running around the leg and foot 300 in FIG. 2 would be caught and used in propulsion by the stiff foot plate 50. A second consideration for having the stiff foot plate 50 closer to the body is that it takes less energy to move a force that is closer because there is less centrifugal force without the lever arm added by distance from the power source (in this case the leg and foot 300.)

A third advantage to moving the stiff part of the swim fin between the heel and the toes of the foot is that the foot can flex naturally at those joints, and cannot easily flex when the stiff foot plate 50 extends beyond the toes.

As shown in FIG. 4, a standard swim fin found in the prior art places the foot of the swimmer into the foot-pocket 250 of the swim fin, where it is held by the securing strap 103. Starting about midway on either side of the foot-pocket, are reinforcing ribs 210. These reinforcing ribs 210 help to stiffen the prior art swim fin 200 (act like a stiff foot plate or paddle.) A second internal set of reinforcing ribs 220 adds more reinforcement and stiffening to the swim fin 200. This combination of reinforcing ribs (although stiffening can be created by simply increasing the thickness of the material of the swim fin 200) provide the prerequisite stiffness to the swim fin 200. One can image that without this stiffness, the swim fin would have as much influence in swimming as an old pair

of jeans tied to your feet (all drag and no propulsion.)

As shown in FIG.5, the ribs 210 can be seen in a side perspective view of the swim fin 200, in an at rest position. FIG. 6 shows that the stiffness of the prior art swim fin 200 extends from the foot-pocket and well beyond the foot-pocket into the prior art swim fin 200 during normal use in swimming.

FIG. 7 shows the maximum amount of flex that can be expected in prior art swim fins 200 during a down-stroke, with the stiff portion of the fin usually extending one half to two thirds of the overall distance of the swim fin 200. This stiff confinement of the toes and their joints means that walking in these prior art swim fins is exceptionally difficult and unnatural. It also causes cramps and soreness in the user's feet, and tendon soreness.

FIG. 8 represents the type of swim sandal/shoe 1300 that is found in the prior art. It generally used hinges on the flaps 107, and the flaps were placed horizontally to the ground. This would allow the flaps 107 to extend when the foot pushed down in a swimming stroke. They would fold down to decrease resistance when the foot was raised towards the body during swimming. This had the advantage of giving more surface area against the water for the foot to push against, and it did let the foot bend and move at the toes (in more enlightened cases). The hinges did nothing to channel the flow of water in a desired direction,

in order to increase propulsion. It only had an effect in the down stroke of the swimming cycle.

FIG. 9, FIG. 10, FIG. 11 and FIG. 12 show several embodiments of the present ergonomic swim fin apparatus.

In FIG 9, the flaps 107 found in the swimming sandal/shoe 1300 are changed to channeling scoops 102. The channeling scoops 102 may be made of metal, plastic or rubber, etc. The swimming sandal/shoe/short swim fin apparatus 1400 is preferably made of any suitable waterproof material normally used for shoes or swim fins.

The channeling scoops 102 are curved surfaces that can either be fixed permanently or applied to a sandal or shoe when needed for swimming. These channeling scoops 102 are placed at an appropriate angle along the side of the sandal, shoe, or short swim fin, to channel the water running off of the top and the bottom of the foot. The channeling scoops 102 direct the water flow in a desired direction, during both the up and down stroke in swimming, as best shown in dashed line in FIG.13, FIG. 14, FIG16 and FIG.17.

Preferably, the channeling scoops 102 are upwardly inclined along each side of the sandal, shoe, or short swim fin, from proximity to the user's toes to the user's heel.

These channeling scoops 102 may seem like a small change from a flap 107 found in FIG. 8, but because of their complex curved shapes 102 and directional channeling curves 105 their influence in the generation of propulsion is exceptional and unexpected. The channeling scoops 102 begin propulsion by angling the foot into the proper disposition in the water, and then channel the flow of water away from the swimmer creating unexpected thrust with tremendous efficiency, and maneuverability.

The channeling scoops 102 allow footwear as small as sandals, shoes, or short swim fins to be used as effectively as swim fins found in the prior art. The channeling scoops 102 also allow the user to use sandals or shoes as beach or general footwear because they allow the foot to flex normally and don't have protruding elements extending in front of the user's toes. The sole of the sandal/shoe or the sole/small flexible blade 108 of the small swim fin 1400 is preferably made of a comfortable material for standing and walking, but sturdy enough to withstand the pressures of walking and swimming.

To enhance the flow of water over the swim fin apparatus 1000, a flexible blade 110 is preferably secured to the swim fin apparatus 1000. The flexible blade 110 is symmetrical, and extends symmetrically and outwardly from the channeling scoops 102, in proximity to the user's toes. This embodiment is shown in FIG. 10.

The flexible blade 110 pushes off of the rolling vortices of water produced by the foot-pocket/sandal/shoe and the channeling scoops 102. In the embodiment shown in FIG.10, the blade tips 117 and centrally positioned channeling groove 116 also help to channel the water into a vector flowing away from the center of the flexible blade 110.

FIG.11 shows the addition of a tail fin 120, which is selectively releasably secured to the centrally positioned channeling groove 116. The tail fin 120 provides a lifting surface in the embodiment of a swim fin apparatus 1600, shown in FIG. 11. This tail fin 120 adds to the efficiency and ease of the swimming stroke when water is channeled over the tail fin at a proper angle of attack. The water flows over the tail fin as shown in dashed lines in FIG. 13, FIG.14, FIG.16 and FIG.17.

Note that the vortices grooves 1201 extend parallel to the leading edge 126 of the tail fin 120. Similar types of grooves 1201 are found on the tail fin of Marlin fish. In the ergonomic swim fin apparatus 1000 disclosed herein, the grooves 1201 interact with the vortices caused by the channeling scoops 102, foot-pocket 101, and flexible blade 110.

FIG. 12 illustrates an embodiment 2000 of the swim fin apparatus that has many of the traits of the short swim fin apparatus 1400 found in FIG. 9, and FIG.

11. The swim fin apparatus 2000 contains a foot-pocket 101, opposing channeling scoops 102 located on opposite sides of the foot-pocket 101, the sole, a first part of a symmetrical flexible blade 108, and at least one securing strap 103.

In this embodiment, the symmetrical flexible blade 108 is detachable from the sole portion 108, so that the distal end 110 of the flexible blade 108 may be selectively attached and removed, for ease of shipping and handling. By providing a releasable attachment means 1081 at the toe end 1085 of the flexible blade 108, the distal end 110 of the flexible blade 108 is removable, enabling the user to easily walk on land, without removing the entire swim fin apparatus 1000 shown in FIG.9.

The releasable attachment means 1082 preferably comprises complimentary hook and catch means 1081, 1111. In the embodiment shown in FIG. 12, the releasable attachment means 1081 is located on each side of the flexible blade 108, in proximity to the toe end of the footwear 2050. The distal end of the footwear 2050 preferably includes at least one aperture 1085 sized to closely receive at least one complimentary pin or cone 1105, located on removable end 2000 of the flexible blade 108. The combination pin and complimentary aperture 1105, 1085 serve to align and position the footwear 2050 in relation to the removable end 2000 of the flexible blade 108.

Preferably three apertures 1085 and three pins 1105 are used to position and align the distal end 200 in relation to the footwear 2050. As shown in FIG. 12, the symmetrical tail fin 2070 is releasably secured to a central portion of the distal end 2000, so that both the tail fin 2070 and the distal end 2000 are removable from the footwear 2050.

Alternately, the symmetrical tail fin is removable from the flexible blade 110 as shown in FIG. 24. In this embodiment, a slit 1421 is provided to closely receive the central portion of the flexible blade 108, and a releasable fastening means 118, 1181 is utilized to removably secure the tail fin 140 to the flexible blade 108.

FIG. 12 includes many of the features shown in FIG. 9 and FIG. 11. As shown in FIG. 12, the flexible blade 110 is selectively attachable and removable from the foot pocket 101. This enables the user to easily remove the portion of the swim fin apparatus 1000 which extends beyond the user's toes, for ease of walking on land, or for more compact transport or storage. Thus, the foot pocket 101 acts as footwear or a short swim fin similar to the embodiment 1400 in FIG. 9. A second part of the swim fin embodiment 2000 that contains the flexible blade 110, a means of attachment 1111 to the assembled short swim fin assembly 2050, and a tail fin 120. Assembly 2050 and assembly 2070 can be attached to one another with the stabilizing pins 1105 ensuring proper placement and stability during use.

This assembly of 2050 and 2070 serves to make the swim fin embodiment 2000 similar in function to the swim fin embodiment 1600 found in FIG. 11, and the swim fin embodiment 1000 found in FIG. 1.

This embodiment 2000 would allow the best of both embodiments, and the flexible blade and tail fin assembly 2070 could be attached with less effort than similar arrangements in the prior art because the assembly 2070 is completely flexible in nature and doesn't have to endure the stresses created with a stiff blade connection. Other flexible blade shapes and tail fin shapes not illustrated here could also be interchanged in this embodiment 2000 along with different sizes and shapes for the channeling scoops 102 to allow the swimmer to adapt his swim fins for special operations, goals or swimming strengths and conditions.

In FIG. 13 and FIG. 14, the flow of water 400 is shown in dashed lines. Notice that the water moved by the foot-pocket 101 flows forward towards the toes and the flexible blade 110, or to the sides 105 where it is captured by the channeling scoops 102 and channeled in the same direction to produce thrust. These views also give another perspective for seeing some of the complex curves possible in the channeling scoops 102 and their directional channeling curves 105. The direction of movement of the foot 500 is noted by an arrow 500, with the flow of water denoted by a dashed line arrow 400. This embodiment 1640 has a

different tail fin 140 than the embodiment 1600 found in FIG. 11. This illustrates the ability to exchange items, such as the tail fin 140, or the channeling scoops 102 to vary the sizes and different shapes to suit the swimming styles, strengths, and swimming conditions. It is also within the scope of this disclosure, and the accompanying claims, to fabricate the swim fin apparatus 1000 disclosed herein as a single unibody construction, to reduce manufacturing costs and increase ease of use and reliability.

Notice how the water flow 400 passes through the path of least resistance 130 between the flexible blade 110 and the tail fin 140. When the attaching arm 142 of the tail fin 140 is made flexible, a proper angle of attack between the tail fin 141 and the flow of water 400 will cause lift 600 as seen in FIG. 14. Lift is caused when the water flows over the lifting surface 143 of the tail fin 140, which acts like a wing in both directions of water flow.

The scale or texture 115 formed by overlapping shapes, similar to scales, is seen in the enlarged view, and may be adapted to cover all surfaces, except the tail fin 140. The scale or texture 115 shown in FIG. 13, aids in the creation of small vortices used in this type of propulsion. The scale or texture 115 is an option and is not required. However, when used, the scale or texture 115 is designed to simulate the size and texture of a fish with approximately the same size as the

swim fin.

FIG. 14 shows a side view of the swim fin 1650, during an up-stroke 500 foot motion shown with a dark arrow 500. This embodiment 1650 has two differences from the embodiment 1640 in FIG. 13. It has a larger channeling scoop 1022 and a directional channeling curve 1052 that can be attached to the foot-pocket 101 by a retaining pin 107. When retaining pin 107 is wedged into the retaining slot 1071 on the reinforcing side 1027 of the channeling scoop 1022. This larger channeling scoop 1022 is designed to extend around the back of the leg and foot 300. This embodiment would eliminate the need for a securing strap 103. This side view also shows the flexible nature of the flexible blade 110 where it bends immediately at the joints of the toes on the leg and foot 300.

In FIG. 15, FIG. 16, and FIG. 17 the dark arrow 550 shows the downward thrust of the foot in the down-stroke of the swimming motion. The swim fin apparatus 1640, shown in FIG. 15, includes curving lines to show the shape and curves of the relatively rigid parts of the channeling scoops 102, the foot-pocket 101, and the tail fin 140. The tips of the tail fin 148, the flexible blade 110 and the securing strap 103 can vary in flexibility by utilizing different materials for these component parts. The flexibility may also vary as a result of different thickness of the material used.

The water flow 400 in FIG. 16 and FIG. 17 is shown in dashed lines 400. The channeling scoop 102 channels and directs the flow of water 400 over the flexible blade 110 and the tail fin 140. Notice that the water 400 must flow a longer distance over the tail fin 140 because the lifting surface 143 of the symmetrical tail fin thus causes lift to occur. In the swim fin apparatus 1680 shown in FIG. 17, the tail curve 141 on the tail fin 140 helps to channel the flow of water to the center of the tail fin 140 creating a thrust vector. The channeling scoop 102 is permanently attached in this embodiment by rivets 106 or other known fastening means, to the reinforcing surface 1027, which allows the channeling scoop 102 to be made of a dissimilar material to that of the foot-pocket 101.

In the swim fin apparatus 1680 shown in FIG. 17, the tail fin 140 is secured to the flexible flat fin 110 along the central axis, by any known securement means 145, such as a screw, bolt, rivet, allowing flexible flat fin 100 to be of dissimilar material to the tail fin 140. Alternately, the foot pocket 108, the tail fin 140 and the flexible flat fin 100 may be fabricated as one unit.

FIG. 18 and FIG. 20 show different perspective views of a swim fin sandal apparatus 1500. The swim fin sandal apparatus is made of any appropriate waterproof material used in manufacturing sandals or swim fins. The material

selected must be strong enough to support the weight of a user, and the pressures exerted by the channeling scoops 102 during swimming. In this embodiment 1500, the instep strap 1014 and 1015 preferably have a system of hooks and loops attached to the top of the base of the instep strap 1014 and to the top of the instep strap 1015, so that the hooks and loops provide releasable and adjustable securement when the top strap 1015 and the bottom strap 1014 are engaged.

The instep strap loop 1018 will hold the two sides of the sandal together at the instep when the instep strap top 1015 is secured to the bottom 1014. Any known securement means may be used. In FIG. 18, the instep strap loop 1018 is shown not secured, and in FIG. 20 the instep strap loop is shown secured.

The fore strap 1016 has on its top inside, a section of hooks or loops 1019 that can attach to the complimentary hooks and loops 1017 located on the other side of the shoe.

When the hooks and loops 1017, 1019 on the fore strap 1016 are adjustably secured together, the user's foot is secured to the sandal 108. In conventional swim fins that have a stiff blade element extending beyond the toes, as shown in FIG. 3, these securing means would not be sufficient, because the forces involved in swimming with the prior art apparatus are too great. But in this embodiment, shown in FIG. 20, the foot sandal 1500, and in all other embodiments representing

this ergonomic swim fin apparatus 1000, the forces are substantially reduced and spread across the entire foot, thus enabling the use of less severe means of securing the ergonomic swim fin apparatus 1000 to the foot 300.

The rear securing strap 1031 is preferably secured against the heel of the foot by a rear securing strap 108. Any known securement means, such as a buckle 1032, hook, catch, button or hook and loop type fastening means may be used to secure the rear securing strap about the user's heel, and would correspond to the securing strap 103 in other embodiments 1250 such as the one in FIG. 19.

One major difference between this embodiment 1500, and most swim fins presently in use and in the prior art (beyond the obvious difference of a channeling scoop 102) is that this embodiment 1500 would have a shaped insole 108, with an instep and shaped body to fit the sole of a user's foot more ergonomically. Left and right soles may be easily accommodated, thus allowing other activities, such as walking or running, in this sandal swim fin apparatus 1500. This would preferably entail the production of left and right versions of the swim fin sandal apparatus 1500, as is the case with most shoes and sandals now being worn.

In this swim fin sandal apparatus 1500, as shown in FIG. 18, the sole 1082 would also be made of a material (or layers of different materials) that would provide padding for the foot to enable the swim fin sandal apparatus 1500 to be

worn comfortably when walking or running, etc. Preferably, sole grooves 1081 are located on instep sole 108, to let the sole breathe in wet or hot environments.

When used, the sole grooves 1081 allow air get to the bottom of the foot. In FIG. 20, the fore strap 1016, 1017 is seen open with the loop section 1019 of the fore strap 1016 exposed. In FIG. 20, the complex curves of the channeling scoop 102, and more particularly, the directional channeling scoop 105 is shown. The reinforcing surface 1027 of the channeling scoop 102 is preferably attached to the swim fin sandal embodiment 1500, with any known securement means 1066.

In FIG. 19, the swim fin apparatus 1250 may be similar to other embodiments already described, with one exception. This swim fin apparatus 1250 is secured to the foot, in a manner similar to the embodiment 1500, shown in FIG. 18. However, a broader set of flaps 1012, 1013 would provide a temporary foot-pocket (shown in FIG.19 by the closed straps 1012 and 1013.) This again could be achieved with simple hook and loop materials (with some relatively simple means of attachment to the flaps 1012, 1013 respectively.) This would provide two important advantages. First, the entire fin could be cast with a simple two part mold and thus reduce the cost and complexity of production. Second, the overlapping flaps would enable some adjustment in the size of the temporary foot-pocket, for better adjustment of the swim fin apparatus to the swimmer's foot.

As seen in the side view of FIG. 21, the swim fin apparatus 1270 shows the two securing flaps 1012 and 1013 in an open position. The loops 1014 are attached by any known means to the underside of flap 1013. Preferably, hook and loop releasable securement means are secured to the top of flap 1012 and to the top portion of flap 1014, so that the flaps are releasably secured when pressed together.

On the underside of flap 1012, more hooks 1015 may be provided for multiple reasons. First, the hook and loop material would be more gentle to the top of the foot (not shown here) than a hard plastic material. Further, the use of the hook and loop means 1015 could be made to secure the foot pad 108 to the underside of flap 1012.

Hook and loop means could also be used to attach the top of the ergonomic swim fin apparatus to existing boots/shoes. This would allow for very quick, easy, and adjustable entry and exit of the user's foot into the temporary foot-pocket. By stepping into the open foot-pocket created by pulling the two flaps 1012 and 1013 apart, the top of the swim boot/shoe equipped with hooks would quickly be secured to the swim fin apparatus 1270. After the second flap 1013 is secured to the first flap 1012, the user's foot within the hook equipped boot/shoe would be securely fastened to the swim fin apparatus 1270. Because the channeling scoop 102 decreases the pressure necessary for good swimming propulsion, and because

it spreads that pressure over a wider area, the flaps 1012 and 1013 can be made of much thinner and more flexible material than prior art foot-pocket material. It should be noted that in this swim fin apparatus 1270, the need for a securing strap at the back of the foot would be optional, limited or unnecessary.

FIG. 22 shows a perspective view of part of a flexible blade 110 and tail fin 120, with the water flow 400 shown in dashed lines. Although the tail fin apparatus shown in FIG. 22 and FIG. 23 differ in some ways, they are substantially the same type of "wing" form where the symmetrical wings are straight in the embodiment 120 shown in FIG. 22, and curved in the embodiment 140 shown in FIG. 23.

Each tail fin apparatus shown in FIG. 22 and FIG. 23, has a connecting point 125 and 145 located along the longitudinal central axis of the swim fin apparatus 1000. The connecting point 125 or 145 can be a permanent attachment, a continuation of the flexible blade 110, or a releasable connecting means. In FIG. 22, the tail fin apparatus 120 has a leading edge 124 and a trailing edge 121 that extend in a substantially straight lines across the tail fin 143. To decrease the drag created by vortices produced by moving through water, the tail fin edge 129 located at the distal sides of the tail fin, has a lifting surface that creates lift and channels the water towards the center of the tail fin 120. This pulls water away

from the edge, and thus decreases the moving water that can be created as vortices and drag on the outer sides of the tail fin 120. The tip 128 of the tail fin edge 129 decreases in size and tapers to a point to enable the drag to be further reduced. The flow of water 400 over the tail fin 120, shown by dashed lines, illustrates the lifting surface 123 of the tail fin 120. An important part of this embodiment 120 is the attaching arm 142 which is centrally located on the longitudinal axis of the ergonomic swim fin apparatus 1000. The attaching arm 142 must have the strength of material to be flexed in opposite directions during each stroke the swimmer takes. The flexing is necessary to align the tail fin 120 to the flow of water 400 at a proper angle of attack so that lift is created to aid in swimming.

FIG. 23 shows a possible tail fin embodiment 140 where the leading edge 144 and the trailing edge 141 are both curved towards the center of the tail fin 140. These curved surfaces 143 serve to channel the water into a relatively small vector of water in the center of the tail fin 120. Again, this pulls the water away from the tips 148 of the tail fin 140 and reduces drag. The flow of water 400 shown in dashed line, also illustrates the lifting surface 143 of the tail fin. In both FIG. 22 and FIG. 23 the space between the flexible blade 110 and the tail fin 120 and 140 respectively is very important. The flexible blade 110 should assist in directing the flow of water over the lifting surface 123 and143 of the tail fins 120 and 140

respectively.

In FIG. 24, one means of attaching a tail fin 140 to a flexible blade 110 is illustrated. In this embodiment 140, the central neck 142 extends symmetrically from the longitudinal axis of the tail fin 140 for securement to the flexible flat blade 110. Any known securement means may be used. FIG. 24 has specialized adaptations 1421 and a securing receptacle 1181, for releasable securement of the extended neck 142 of the tail fin 140 to the central longitudinal axis of the flexible blade 110.

A securing hook 118 is preferably located on both sides of the flexible blade 110. By having securing receptacles 1181 on both the lower and the upper portions of the attaching extended neck 142, these receptacles 1181 can slip over the securing hooks 118 to provide a simple, easy, and secure method of attaching the tail fin 140 to the flexible blade 110. Releasable securement of the tail fin 140 to the flexible flat blade 110 allows different styles, shapes and sizes of tail fins 140 to be selectively attached to a single flexible blade 110.

The specialized adaptation 1421 is preferably a thin membrane of the flexible arm 142 which would act to form tension between the tail fin 140 and the flexible blade 110, to keep the security hook 118 secured in the security receptacle 1181. This tension would only be great enough to keep the tail fin 120 from

separating from the flexible blade 110 during use, but allow for the user to pull the attaching upper and lower arms 145 away from the securing hook 118 when a change of tail fins 140 is desired.

Although specific features of this invention are shown in some drawings and not others, this is for convenience only as each feature may be combined with any or all of the other features in accordance with the invention.

Various modifications may be made to the disclosed ergonomic swim fin apparatus, and other modifications may be made by one of average skill in this art based upon the teachings herein. Such modifications are intended to fall within the scope of this patent application, and the appended claims.